BIG RUN WATERSHED INVESTIGATION REPORT

MUSKINGUM RIVER BASIN

KNOX COUNTY, OHIO

April 1968

UNITED STATES DEPARTMENT OF AGRICULTURE

Soil Conservation Service

CONTENTS

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MARCH 1968

THE WATERSHED IN BRIEF

Big Run Watershed consists of 20,416 acres (31.9 square miles) in Knox County. Center of the watershed is about 7 miles southeast of Mt. Vernon, or 40 miles northeast of Columbus - the state capital.

Big Run flows generally north to its outlet into Kokosing River - about 6 miles above Kokosing's outlet into Walhonding River. Big Run represents about 6.6 percent of the Kokosing Basin, or about 1.4 percent of the Walhonding Basin. Elevations vary from 930 feet at the outlet to 1200 feet at several points in the headwaters.

Martinsburg, the only village in the watershed, is located at the head of Elliott Run. No major highways traverse the watershed. State Route 586 running southeast to northwest, crosses the flood plain in the upper reach of the main stem. Several county and township roads cross the flood plain. There are no railroads, industries, or commercial enterprises within the watershed.

This watershed is in the Western Allegheny Plateau Land Resource Area of the East and Central General Farming Region. Ohio's designation is the Glacial Sandstone and Shale Resource Area (Gss).

Moderately rolling hills surround the bottom lands along Big Run and its tributaries. Glaciers have covered this portion of Ohio twice within the Pleistocene Epoch. Glacial till of the earlier Illinoian glacier covers the eastern half of the watershed; the remainder of the area is covered by deposits of till left by the later Wisconsin glacier. These till deposits are thin to medium in thickness, except where they fill in old stream valleys 100-200 feet deep that date from Teays (pre-glacial) age. One old Teays valley to old Stream valley follows Dudgeon Ditch west through Kaiser Ditch, and out of the watershed. Another such valley follows Big Run from Kaiser Ditch to the Kokosing River. Lake deposits of silts of Wisconsin age overlie the Illinoian till in the Dudgeon Ditch valley.

Bedrock, beneath the galcial deposits consists, of the Cuyahoga and overlying Logan Formations both Mississippian in age. These formations have a general dip of about 30 feet per mile to the southeast. The formations consist principally of sandstone

siltstone, and shales. The topography is influenced more by these bedrock formations, than by the thin mantle of glacial till over them.

Bottomland soils in the watershed are Glenford, Fitchville, and Luray in the Lake deposit, Carlisle muck in depressional areas, and Chili in glacial outwash. Upland soils are Alexandria, Cardington, Loudonville, and Hanover, all formed in the glacial till.

Land use in the watershed is estimated to be 66 percent cropland, 20 percent pasture, 10 percent woodland, and 4 percent other uses. Average size of farms is about 135 acres. Value of land and buildings is about $280 per acre. Annual sale of farm products amounts to an estimated $7,600 per farm. Sales of crops, dairy products, and cattle represent the major sources of receipts. About 40 percent of the farm operators work off the farm 100 days, or more, per year. Five percent of the farms are operated by tenants. All land is privately owned.

WATERSHED PROBLEMS AND NEEDS

Floodwater Damages

Annual floodwater damage to crops and pasture is estimated to be $5,465. Other agricultural floodwater damage is estimated at $1,870 annually. Approximately 960 acres of flood plain are subject to inundation by a 50-year flood. Land use in the flood plain consists of: cropland, 65 percent; pasture, 18 percent; woodland, 8 percent; and other (including idle), 9 percent.

Annual damages to roads and bridges is about $2,506. Indirect damages include 10 percent of agricultural damages and 15 percent of transportation damages.

Erosion and Sediment

Erosion of cropland and pasture is not a serious problem. Waterborne sediment contributes to limited damage to crops and pasture on the flood plain.

Woodlands are generally in poor hydrologic condition. This condition contributes to excessive runoff and frequency of flooding.

Agricultural Water Management

At least half of the flood plain needs tile and/or surface drainage. Much of the existing channel in the upper flood plain is tortuous, clogged with debris and trees, and/or shallow; therefore, adequate outlets for tile drainage are not available.

There is no apparent need for irrigation water. Water for livestock and general farm use can be provided through existing programs.

Non-Agricultural Water Management

Fishing within the watershed is practically non-existent. Limited fishing, in the lower reaches and "holes" on the main stem, produces catches of blue gill and "rough fish".

One private fishing club with a closed membership of 100 members has a sizeable waiting list of membership applications.

The PL-566 application lists "recreational facilities for local people" as one of the project objectives.

There is no apparent need for municipal water supply or water quality management control.

TABLE I

ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE

Big Run Watershed, Muskingum River Basin, Ohio

(Dollars) 1/

ITEM	DAMAGES
Crop and Pasture	5,465
Other Agriculture	1,870
Transportation	2,506
Subtotal	9,841
Indirect	875
Total Damage	10,716

1/ Price Base - Adjusted Normalized. April 1968

PHYSICAL POTENTIAL FOR MEETING NEEDS

The area has an average annual rainfall of 39 inches which yields about 14 inches of annual runoff. Proper management of the runoff will provide the area with a well-balanced water management program.

Watershed problems and needs can be solved through a well-organized plan of land treatment and structural measures. Several types of land treatment measures have been installed on lands contiguous to untreated areas. These lands with existing land treatment measures attest to the physical potential for additional installations. To supplement the effects of land treatment, a combination of structural measures is necessary. The combined flooding and drainage problem indicates a need for channel improvement. The extent of this improvement is limited by the resulting high velocities and bridge capacities. A second possible type of structural measure which is effective in reducing flooding is the floodwater retarding structure. Physical limitations do not appear to be a serious problem since topography, soils, and foundations seem adequate for a wide range of structure sizes. Several of the potential reservoir sites have a development potential for multiple purposes. These impoundments could be available for recreation, fish and wildlife, water quality management, or other beneficial uses.

LOCAL INTEREST IN PROJECT DEVELOPMENT

Local people have prepared an application for a PL-566 Watershed Protection and Flood Prevention Project. This application has been reviewed by the Ohio Department of Natural Resources. Approval has been given for the Soil Conservation Service to procede with a study of the watershed and to prepare this preliminary investigation report.

If a feasible project is agreed upon and a watershed work plan is prepared, Knox County Commissioners would have legal authority to proceed with project action.

WORK OF IMPROVEMENT FOR POTENTIAL DEVELOPMENT

Land Treatment Measures

More than half of the bottomlands need tile and/or surface drainage to reach optimum productivity.

Upland cropland needs contour strip cropping and grassed waterways. Some rotation cropland should be converted to hayland or pasture. Most permanent pasture needs treatment; about 75 percent needs seeding to desirable forage species - the remainder needs treatment with lime and fertilizer. Tree planting is needed to

establish a protective cover on some of the steeper, eroded upland. Existing woodlands and reforested areas should be protected from fire and grazing.

Structural Measures

Six potential reservoir sites were examined. Four of these would each control approximately half a square mile; whereas, the remaining two would each control about three square miles. Study of the four small sites was terminated when it became apparent that their costs would exceed the cost of similar protection provided by channel improvement. Evaluation of the effects of the various structural measures was aided by the use of a flood routing computer program. Design peak flows were determined by routing a storm of the design frequency through the watershed. The utilization of those peaks in conjunction with Manning's formula, determined in channel proportioning. The apparent best system of structural measures is two reservoirs and 5.2 miles of channel improvement.

Multiple-purpose development is limited at both reservoir sites by existing developments in the potential storage area. Recreation or other development could be included at reservoir Site No. 1 if the structure were located at a downstream site. The maximum permanent pool at that site would be 70 acres. A larger pool would inundate the 16-, 20-, and 24-inch gas pipe lines. Multi-purpose development at reservoir Site No. 2 is limited by State Route 62. Since no economical site could be identified downstream, the reservoir was considered only for floodwater retardation. For a discussion of recreational development at Site No. 1, see the section entitled, Additions and Alternatives Considered.

TABLE II-A

STRUCTURE DATA

Big Run Watershed, Muskingum River Basin, Ohio

Site Number	Drainage Area	Est. Height of Dam	Est. Vol. of Fill	PRINCIPAL SPILLWAY Type	Release Rate	EMERGENCY SPILLWAY Type	% Chance of Use	Max Surface Area Em. Spill Level
	(Sq.Mi.)	(Feet)	(Cu. Yd.)		(CSM)			(Acre)
1	2.6	30	40,000	Reinforced Concrete Conduit	13	Veg.	2	62
2	3.3	35	135,000	Reinforced Concrete Conduit	13	Veg.	2	53
TOTAL	5.9		175,000					115

April 1968

TABLE II-B

CHANNEL IMPROVEMENT

Big Run Watershed, Muskingum River Basin, Ohio

Channel Designation	Length of Reach	Watershed Area 1/	Needed Channel Capacity	Bottom Width	Depth	Velocity in Chan. 2/	Estimated Volume of Excavation
	(100 Ft.)	(Sq. Mi.)	(cts)	(Ft.)	(Ft.)	(F/sec.)	(Cu. Yds.)
Reach #1	29	4.1	700	20	5.1	4.2	16,100
Reach #2	64	5.4	800	24	5.0	4.4	38,000
Reach #3	25	2.6	570	14	5.1	4.2	5,600
Reach #4	25	4.0	900	28	5.0	4.4	7,400
Reach #5	55	7.7	1,600	40	5.9	5.0	71,000
Reach #6	25	15.0	1,650	50	5.3	4.9	35,000
Reach #7	24	18.2	1,830	55	5.3	5.1	27,000
Reach #8	55	22.1	1,540	45	5.2	5.1	40,700
TOTAL	277						240,800

1/ Watershed area is uncontrolled area.
2/ Bank-full velocities.

April 1968

TABLE III

RESERVOIR STORAGE CAPACITY

Big Run Watershed, Muskingum River Basin, Ohio

Site No.	Drainage Area	STORAGE CAPACITY EVALUATED FLOOD PREVENTION Sediment		Detention		Total		Additional Storage Capacity Available
	(Sq.Mi.)	(Ac.Ft.)	(In.)	(Ac.Ft.)	(In.)	(Ac.Ft.)	(In.)	(Ac.Ft.)
1	2.6	170	1.2	310	2.2	480	3.4	500
2	3.3	220	1.2	395		615	3.4	
TOTAL	5.9	390		705		1,095		500

April 1968

NATURE AND ESTIMATE OF COSTS OF IMPROVEMENT

The ratio of construction cost to volume of compacted earth fill for reservoirs, and of excavation material for channels, was the basis for estimating construction costs. These ratios were determined for the various reservoirs and channel improvement measures actually installed within the state. Volumes to be multiplied by the ratios to arrive at the construction cost estimates were determined from calculations based on USGS topographic studies for the two reservoirs and on 15 surveyed channel sections for channel improvement. All construction sites were examined in the field to identify any unusual cost factors.

Engineering and project administration costs were in accordance with cost records from the Soil Conservation Service files for similar structural measures.

The determination of land, easements, and rights-of-way costs was based on local property values, field observations, and elevations taken from USGS quadrangle sheets. $43,400 was included for land, easements, and rights-of-way and $38,000 for utilities.

Cost of administering contracts was taken to be 3 percent of construction costs. Total cost equaled $9,900.

The average operation and maintenance costs for each year during the project life was estimated at $420 for the two floodwater retarding structures and $2,550 for the 5.2 miles of channel improvement.

TABLE IV

ESTIMATED STRUCTURAL COST

Big Run Watershed, Muskingum River Basin, Ohio

Item	Amount Planned	Estimated Total Cost (Dollars) 1/
Construction:		
Floodwater Retarding Str.	2	214,000
Channel Improvement	5.2 miles	115,700
Subtotal Construction		329,700
Engineering		49,500
Land Easements & R. W.		81,400
SUBTOTAL		460,600
Project Administration		75,700
GRAND TOTAL		536,300

1/ Price Base 1967.

April 1968

TABLE V

DISTRIBUTION OF STRUCTURAL COST

Big Run Watershed, Muskingum River Basin, Ohio

Item	Installation Cost (Dollars) 1/			
	Construction	Engineering	Land Easements and R. W.	Installation Cost
Floodwater Retarding Structure No. 1	66,000	9,900	15,000	90,900
Floodwater Retarding Structure No. 2	148,000	22,200	19,500	189,700
Channel Improvement	115,700	17,400	46,900	180,000
SUBTOTAL	329,700	49,500	81,400	460,600
Project Administration				75,700
GRAND TOTAL	329,700	49,500	81,400	536,300

1/ Price Base 1967.

April 1968

TABLE VI

COST ALLOCATION AND COST SHARING SUMMARY

Big Run Watershed, Muskingum River Basin, Ohio

(Dollars) 1/

	COST ALLOCATION	COST SHARING	
		P. L. 566	OTHER
	Flood Prevention	Flood Prevention	Flood Prevention
Structure No. 1	90,900	75,900	15,000
Structure No. 2	189,700	170,200	19,500
Channel Improvement	180,000	133,100	46,900
GRAND TOTAL	460,600	379,200	81,400

1/ Price Base 1967 .

April 1968

EFFECTS AND ECONOMIC FEASIBILITY OF POTENTIAL DEVELOPMENT

For the level of development described, the extent of protection would vary throughout the flood plain. Within the high damage area, protection would be provided against a storm, which on the average, could be expected to occur once in five years. This area extends from the junction of Big Run with Dudgeon Ditch along both streams to the end of the channel improvement. Reach Nos. 6 and 7, downstream from the junction, would receive approximately a 3-year level. Further downstream, protection would decrease to the end of channel improvement. Following are the acres protected for the three different levels.

5 - year	580 acres
3 - year	100 acres
less than 3 - year	30 acres

Average annual flood reduction benefits were estimated to be \$8,539 from structural measures and \$218 from land treatment. Land enhancement to agriculture, including more intensive use and some changed land use, was estimated to provide benefits of \$10,467. Agricultural water management benefits were estimated to be \$2,331, annually.

Local secondary benefits would be \$2,069 annually.

The ratio of average annual genefits to average annual cost, for all works of improvement, woule be 1.1:1. The benefit-cost ratio, excluding local secondary benefits, would be 1.0:1. If project administration costs were excluded, a benefit-cost ratio of 1.3:1 would result. Summary of benefits, costs, and comparisons are listed in TablesVII and VIII.

TABLE VII

ANNUAL COST

Big Run Watershed, Muskingum River Basin, Ohio

(Dollars) 1/

Evaluation Unit	Amortization of Installation Cost 2/	Operation and Maintenance Cost	Total
1	15,605	2,970	18,575
Project Administration			2,565
GRAND TOTAL	15,605	2,970	21,140

1/ Price Base: Installation 1967, O&M 1967.

2/ 100 years @ 3 $\frac{1}{4}$ percent interest.

April 1968

TABLE VIII

COMPARISON OF BENEFITS AND COSTS - STRUCTURE MEASURES

Big Run Watershed, Muskingum River Basin, Ohio

(Dollars) 1/

	AVERAGE ANNUAL BENEFITS 1/						
Evaluation Unit	Damage Reduction	More Intensive Land Use	Drainage	Secondary	Total	3/ Avg. Annual Cost	Benefit Cost Ratio
I	8,539	10,467	2,331	2,069	23,406	18,575	1.3:1
Project Administration						2,565	
GRAND TOTAL	8,539	10,467	2,331	2,069	23,406	21,140	1.1:1

1/ Price Base - Adjusted Normalized for benefits, operation and maintenance, and other economic costs.

2/ In addition, it is estimated that land treatment measures will provide flood damage reduction benefits of $218 annually.

3/ From Table VII

April 1968

ALTERNATE OR ADDITIONAL POSSIBILITIES

One possible addition to the previously described structural measures is recreational development. The 70-acre lake and surrounding lands could support a development consisting of camp sites, boat docks and ramps, beaches, trails, picnic area, sanitary facilities, and parking lots. Sufficient studies were conducted to insure that the increment of recreational development could be economically justified if local interest is expressed.

It was assumed that the problem areas within the headwaters could be served by other going programs. Drainage outlets, made available through downstream improvements, would allow individual and group projects under those programs.

It should be recognized that the system of structural measures proposed is based on a limited number of surveys and interviews. A somewhat different system may be proposed upon further study. Perhaps one of the four sites studied, but not included in the present system, would be economically feasible.